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THE ECOLOGY AND ABUNDANCE OF *HYMENOXYS TEXANA* (ASTERACEAE)

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ABSTRACT

During 2009-2010, the ecology of *Hymenoxys texana*, Texas Prairie Dawn, was studied at three prairie sites in Harris County, Texas to determine population variations across various saline prairie microhabitats and whether a 1989 recovery plan proposed for the species has been succeeding. Associated plant species, plant community structure and abundance comparisons between years for *H. texana* were also assessed. Densities of *H. texana* varied between zero and 429 individual plants/m^2, with an average of approximately 83 plants/m^2. No overall significant differences in plot densities between sites were found, although a significant increase in *H. texana* occurred across sites from 2009 to 2010. Notable plant associations included *Thurovia triflora, Chloris texensis, Valerianella florifera, Willkommia texana var. texana, Atriplex texana* along with 12 other regionally restricted species for a total of 378 associated taxa. A new Houston Coastal Prairie association is proposed: the *Sporobolus pyramidatus–Spergularia echinosperma–Iva angustifolia–Hymenoxys texana–*(*Thurovia triflora*) Herbaceous Vegetation, the Houston Saline Prairies association. A checklist of the flora of Warren Ranch and Jack Road Prairies is appended.

Hymenoxys texana (Coult. & Rose) Cockerell (Asteraceae) is an extremely rare (G2S2) endemic plant that is restricted to the Texas Gulf Coastal Plain of Fort Bend, Harris, and Trinity counties. The species is based upon an unnumbered specimen collected in 1889 near Hockley (Harris County), Texas by F. W. Thurow. It was originally described under the name *Actinella texana* by Coulter and Rose (1891). In 1904, Cockerell proposed the new combination *H. texana.* Until 1970, the species appeared to have vanished from Texas botany. It is not listed in Texas Plants – A

Checklist and Ecological Summary by Gould (1962). Correll and Johnston (1970), in the Manual of the Vascular Flora of Texas, stated "Rare in sandy soils near Hockley and Houston, Harris Co., probably extinct (no known collections after 1900)." In 1981, James W. Kessler discovered three populations growing in "buffalo wallows" or small depressions in Harris County, these being the first known collections of this species since 1889-90 (Mahler 1983).

*H*ymenoxys *texana* was listed as endangered by U.S. Fish and Wildlife Service (1986). The founding information was assembled by Bridges (1988). Approximately 60 occurrences (TxNDD 2010) of *H. texana* have been recorded, these primarily in Harris County. Unfortunately, many of these occurrences have been lost to development. At the present time, the taxonomy appears to have become stabilized (Bierner 2006) and the number of individuals, distribution, and basic habitat structure is known. The primary objective of this study was to secure information that may be used now (or later) to determine if the recovery plan for *H. texana*, as proposed by Young and Brown (1989) has been succeeding. The study included identifying the habitat for the species; monitoring populations; and documenting associated species, vegetation types (associations), and structure of the community, all with emphasis on demography. Until this report, there have been no demographic studies of the species.

Background

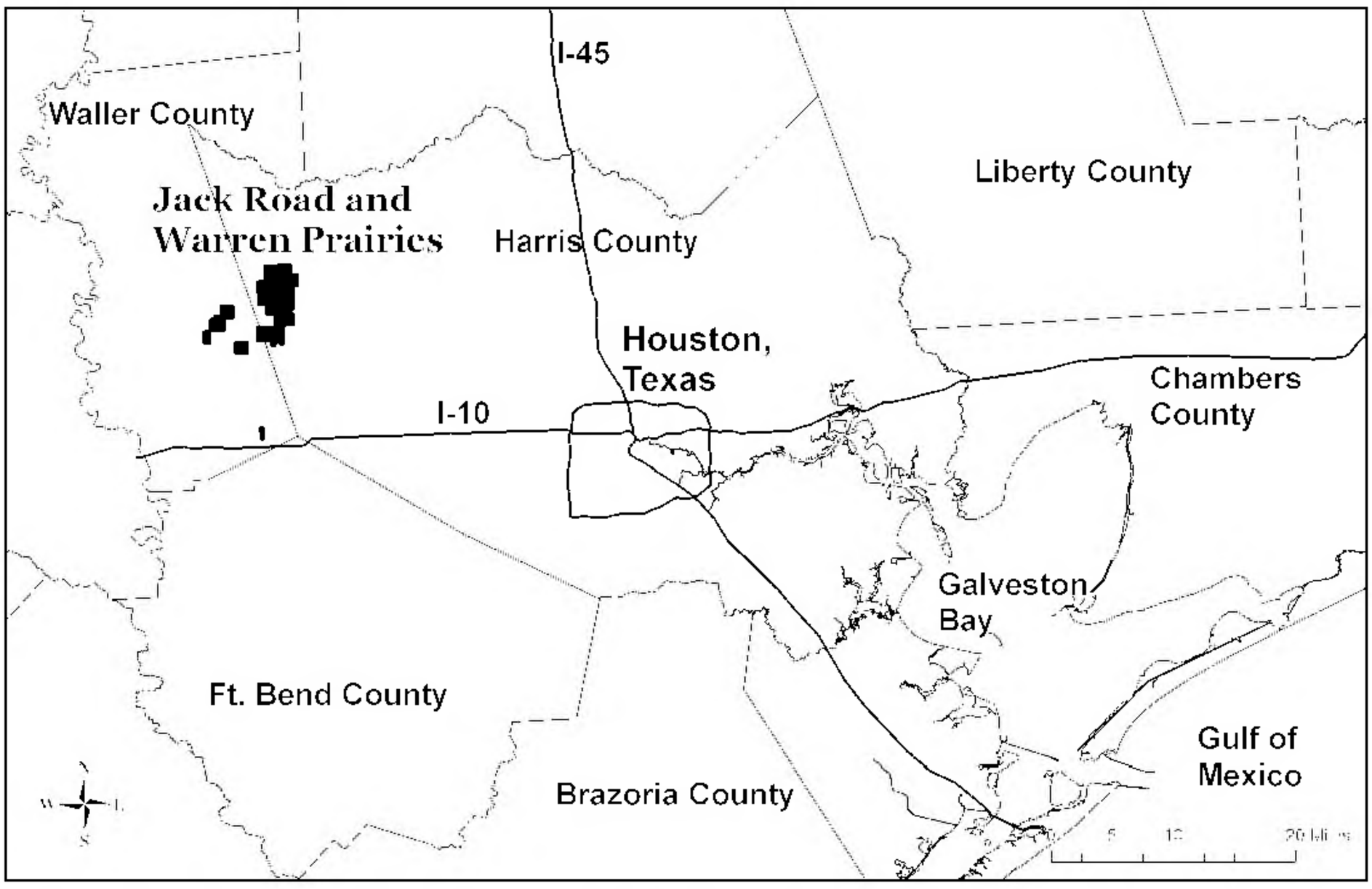
Hymenoxys texana (Fig. 1) is limited to saline prairies with cryptogamic soils within the Houston Coastal Prairie (*Muhlenbergia capillaris* Herbaceous Vegetation Alliance) (National Vegetation Classification System 2012). Many of the species that occur in these saline prairies are absent from or uncommon in adjoining vegetation. These soils are shallow, saline, and support a moderate diversity of annual and perennial herbs that commonly occur in barren slicks and the base of mima mounds (Bierner 2006; Mink et al 2010). It is thought that the natural pattern of disturbance (droughts, fires, and floods) is necessary to maintain the areas, though the exact role of disturbance is not clear.

Figure 1. *Hymenoxys texana* (Photograph by Singhurst).

Site history

The Katy Prairie region is located in northwest Harris County, Texas, near the city of Katy (Map 1). The area is subject to mixed use, largely involving rotation of crop agriculture (rice), livestock grazing, and, in some areas, salt mining. Katy Prairie Conservancy, a local land trust organized for the preservation of the remaining Katy Prairie remnants, purchased the Warren Ranch property at a 70% buy-in rate. Currently, the remaining 30% remains under the Warren family ownership. Two additional portions of the Warren Prairie, totaling approximately 115 ha (285 acres) were purchased to be preserved as the *Hymenoxys texana* conservation areas. Another portion of the property, the Jack Road Prairie, consisting of 206 ha (511 acres) has a complex system of saline prairies and serves as prime habitat for *H. texana,* but it is in private ownership.

Hymenoxys texana populations have been surveyed in at least one of these three areas in 2003, 2005, 2006, 2008, 2009, and 2010. Before 2008, the surveys were limited to locating *H. texana* populations and inventories of associated plant species. In 2008, a census was conducted to estimate the population size of the Jack Road and Warren Prairie areas. Additionally, the species of each of the three areas mentioned above were enumerated for comparative purposes.



Map 1. Jack Road and Warren Prairies, Katy Prairie Conservancy, Harris and Waller counties, Texas.

Soils

The soil of Jack Road and Warren Prairies — formed from the fluviomarine deposits of the Lissie Formation — is being considered by the Natural Resources Conservation Service (NRCS) as representing its own individual soil series. Currently, the soils on site are predominantly classified as within the Gessner Complex (Gs and Ge) or as Katy Fine Sandy Loam (Kf) (Wheeler, 1976). However, due to the distinctive presence of a natric horizon, the Gessner and Katy Loam series do not accurately reflect the Warren Ranch soil type (NCSS 2012). The natric horizon includes a high

content of exchangeable sodium, an important characteristic and developmental trait of the saline prairie habitat (Pettry & Switzer 1999).

Climate

The area is characterized by a temperate coastal climate. During the growing season of *Hymenoxys texana* (February to April), average ambient temperature ranges from 8.9 C. (48°F) to 26.1 C (79°F). Rainfall averages approximately 22.9 cm (9 inches) for the three month span (National Climatic Data Center 2011).

METHODS

Sampling design and data analysis

Using ArcGIS v9.2, a polygon shape file estimating the location and limits of all saline barrens within the three sections of surveyed property was created. From early February to mid-March, each site was visited to determine the presence or absence of *Hymenoxys texana* in each barren. GPS and Arc Pad 6.0 software were used to find the approximate boundary of each polygon of each population. These were numbered, with a total of 45 randomly selected for inventory. The inventory was conducted by randomly placing a one meter square (1 m^2) quadrat within the boundary of each barren. A census of *H. texana* and inventory of all plant species present were taken.

The abundance data were compared between the three tracts of property and also for the two survey years. The average abundance was calculated and a two-way ANOVA was performed with tract, year, and the possible interaction between them as explanatory variables. Comparisons of means were performed using the Tukey HSD test. All data were square root transformed and assessed to ensure that assumptions of homogeneity of variance and normality of residuals were met (Quinn and Keough, 2002). Tests were carried out in R v 2.10.1 (R Development Core Team 2010).

Floristic inventory

A floristic survey of the prairies was conducted between 2007 and 2010. Voucher specimens were collected and are deposited at Baylor University Herbarium (BAYLU) and the Katy Prairie Conservancy Herbarium (no acronym), Katy Conservancy Field Office, Waller, Texas.

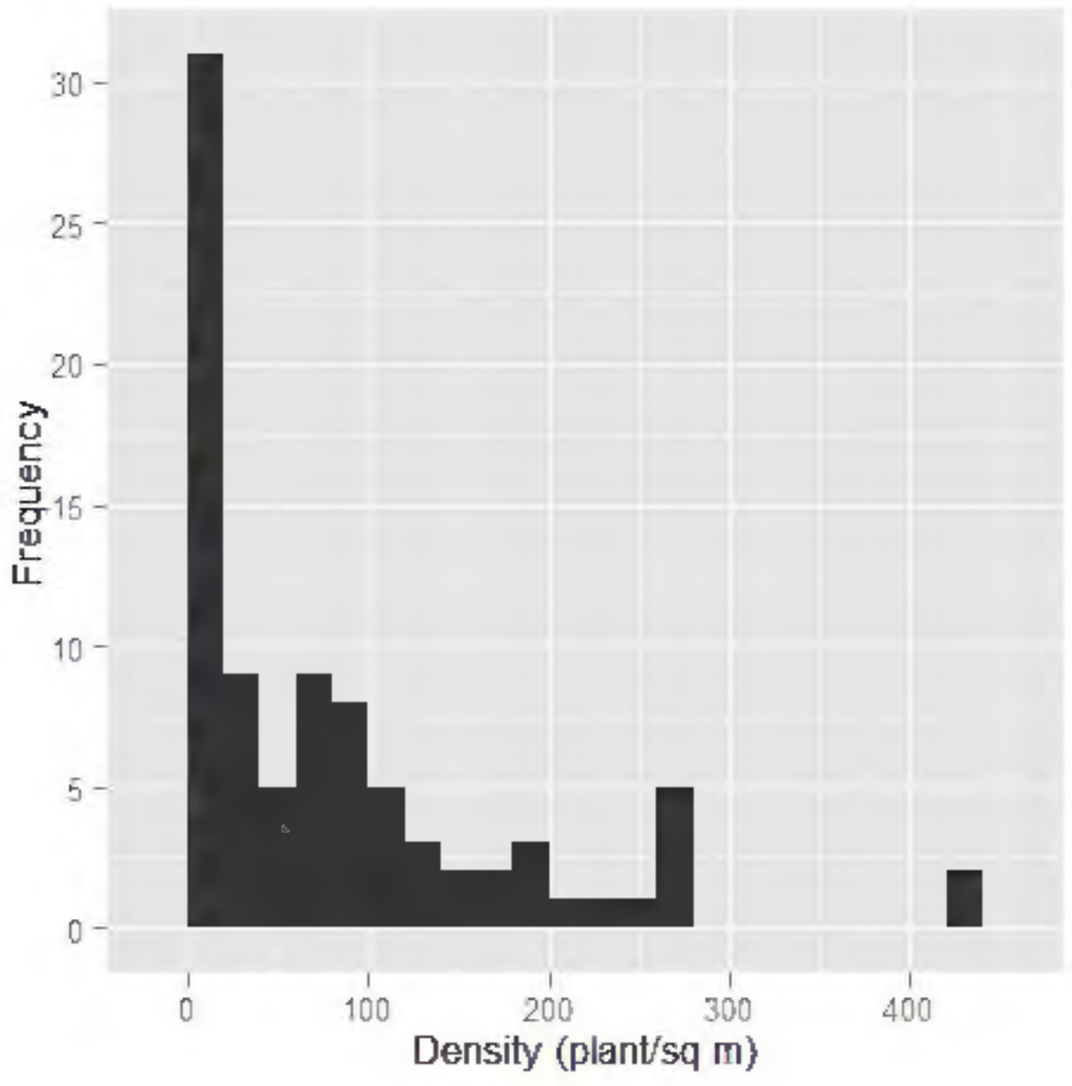


Figure 1. Histogram of *Hymenoxys texana* density per m^2. It is presented here untransformed; for analysis, the data was square-root transformed.

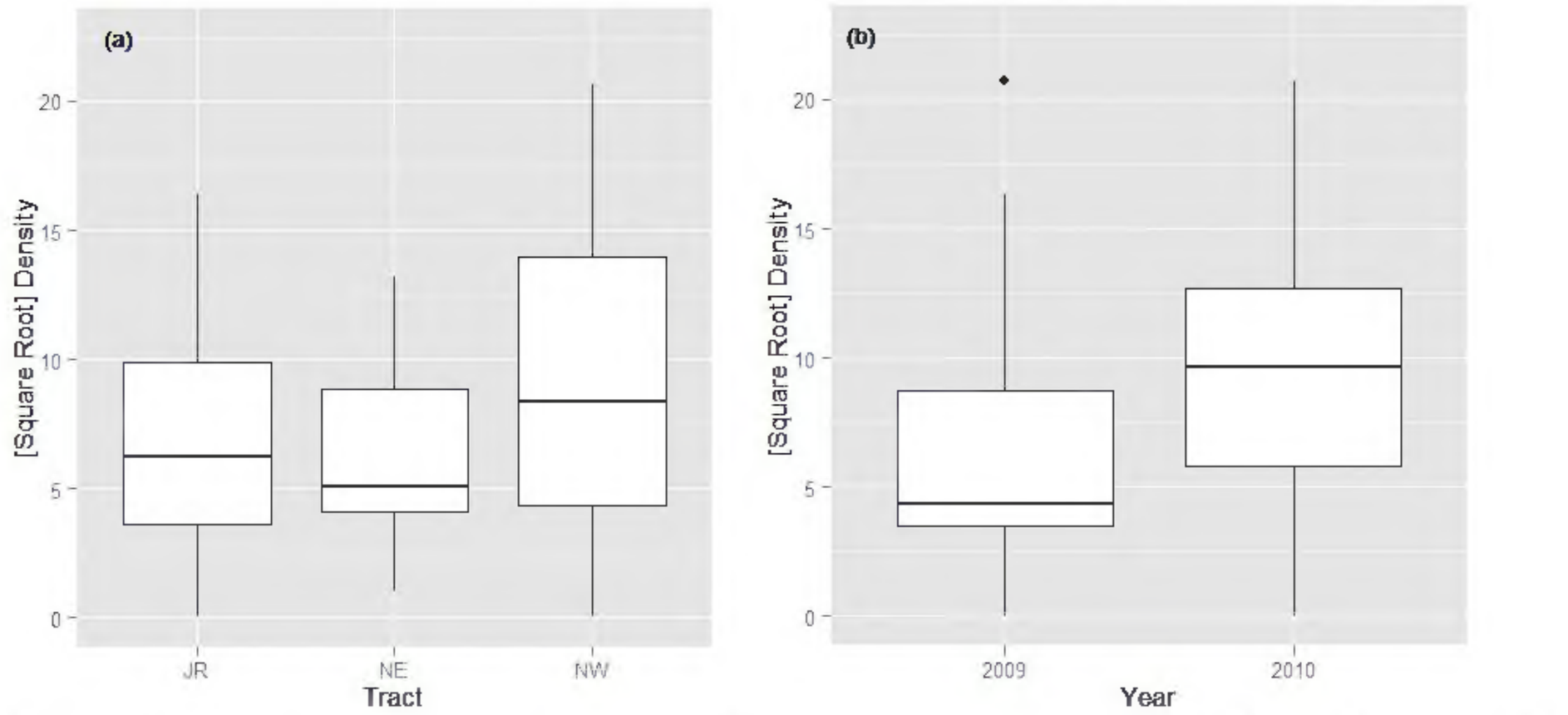


Figure 2. *Hymenoxys texana* mean abundance per m² square-root transformed for normality by (a) tract; and (b) year. The dark middle line in each box represents the median of the data, the lower and upper edges represent the 25% and 75% quartiles, respectively, and the whiskers represent the minimum and maximum values excluding outliers. Maximum-value outliers are considered any data point beyond two times the 75% quartile; thus, one outlier in 2009 was found with a density of 429 plants/m^2. The tracts are as follows: JR is the Jack Rd tract; NE is the Warren Prairie northeast tract; NW is the Warren Prairie northwest tract.

RESULTS

The survey of *Hymenoxys texana* resulted in the discovery of unknown populations in areas previously recorded as lacking the species. Additionally, all previously known occurrences were confirmed to have a continued *H. texana* presence. Within each barren, the three tracts (see Site History) were found to have a variation of density from 0 to 429 individual *H. texana* plants per m² with an average of 83 plants/m² ($n = 87$) (see Figure 1). No consistent significant differences were found between the densities in the three prairie tracts studied. The ANOVA (Fig. 2) did find that a significant increase in abundance occurred between 2009 and 2010 ($F_{1,81} = 9.35$; $p = 0.003$) across all tracts.

Floristic assessment

A total of 378 taxa representing 225 genera and 80 families were documented for the Warren Ranch (Appendix). Of this total 26 (6.9%) are non-native species. Plant families with the largest number of species were Poaceae with 75 (19.8 %), Asteraceae with 58 (15.3%), and Cyperaceae with 28 (7.4%). Several rare and regionally significant plant species were documented and are listed in Table 1. The general distribution and global/state ranks are also presented.

Plant community association

One plant community association within the Houston Coastal Prairie (*Muhlenbergia capillaris* Herbaceous Vegetation Alliance, National Vegetation Classification System 2012) is newly described and restricted to Texas. The *Sporobolus pyramidatus–Spergularia echinosperma–Iva angustifolia–Hymenoxys texana–*(*Thurovia triflora*) Herbaceous Vegetation (Houston Saline Prairies) is proposed for the first time. This coastal prairie association is restricted to Brazoria, Chambers, Ft. Bend, Galveston, Harris, and Trinity counties in the upper coastal region of Texas. This association has two distinct phases. Phase 1 is dominated by *Sporobolus pyramidatus*, *Spergularia echinosperma*, *Iva angustifolia*, and *Nostoc* (Nostocaceae) (Table 2). Phase 2 is dominated by *Sporobolus pyramidatus*, *Hymenoxys texana*, *Thurovia triflora*, and *Willkommia texana* (Table 2). This association consists of saline prairies primarily dominated by annual plants (54%). The

association persists on sandy and clay prairie landscapes with salty barren spots adjacent to or between mima mounds. The barren spots hold water during the wet season, support *Nostoc* (Nostocaceae) and generally have cryptogamic soils. Characteristic species include *Crassula aquatica*, *Houstonia rosea*, *Iva angustifolia*, *Lepidium densiflora*, *Phemeranthus parviflorus*, *Plantago aristata*, *Spergularia echinosperma*, *Vulpia octoflora*, and *Willkommia texana* var. *texana*. Several rare, endemic and regionally significant plants frequently occur in these barrens. These include *Atriplex texana*, *Chloris texensis*, *Gratiola flava*, *Lechea san-sabeana*, *Schoenolirion wrightii*, and *Valerianella florifera*. Other species of this association include *Ammoselinum butleri*, *Callirhoe involucrata*, *Centunculus minimus*, *Cleomella angustifolia*, *Coreopsis basilis*, *Distichlis spicata*, *Evax verna*, *Evolvulus sericeus*, *Krigia occidentalis*, *Linum imbricatum*, *Nothoscordum bivalve*, *Oenothera spachiana*, *Opuntia macrorhiza*, *Portulaca umbraticola*, *Schoedonardus paniculatus*, *Sida cilaris*, and *Spartina spartinae*. The plant community association has very few high quality sites remaining and a ranking of G1G2S1S2 (TxNDD 2009) is recommended.

GENUS_SPECIES	COMMON NAME	USA DISTRIBUTION	RANK
Atriplex texana	Texas saltbush	TX (endemic)	G4S4
Chloris texensis	Texas windmill grass	TX (endemic)	G2S2
Cleomella angustifolia	Northern Rhombo-pod	CO, KS, NE, OK, TX	G5S1S2
Gaura lindheimeri	Lindheimer's butterfly-weed	LA, TX	G3G4S3S4
Gossypianthus lanuginosus var. *tenuiflorus*	woolly cottonflower	AR, LA, OK, & TX	G4S3
Gratiola flava	yellow hedge-hyssop	LA, TX	G3S3
Hymenoxys texana	Texas prairie dawn	TX (endemic & LE)	G2S2 (LE)
Lechea san-sabeana	San Saba pinweed	LA, TX	G4S4
Liatris acidota	slender gayfeather	LA, TX	G4G5S4S5
Lupinus subcarnosus	Texas bluebonnet	AR, TX	G5S5
Phacelia glabra	**smooth scorpionweed**	AR, LA, OK, TX	G4S2
Rudbeckia texana	Texas coneflower	LA, TX	G3S3
Schoenolirion wrightii	Texas sunnybell	AL, AR, LA, & TX	G3S2
Thelesperma flavodiscum	East Texas greenthread	AR & TX	G3S3
Thurovia triflora	three-flower broomweed	TX (endemic)	G2G3S2S3
Tradescantia subacaulis	stemless spiderwort	AR, TX	G4S4
Valerianella florifera	Texas cornsalad	TX (endemic)	G3S3
Willkommia texana var. texana	Texas willkommia	TX (endemic)	G3G4T3S3S4

Table 1. Rare and regionally significant plants inventoried (2003-2010).

SITE	GENUS_SPECIES	% COVER
Jack Road	*Sporobolus pyramidatus*	8.4
	Spergularia echinosperma	6.8
	Iva angustifolia	3.6
	Nostoc spp.	3.3
	Bare	50.8
North Warren Ranch	*Sporobolus pyramidatus*	6
	Hymenoxys texana	3.3
	Thurovia triflora	2.9
	Willkommia texana	2.3
	Bare	55.6

Table 2. Percent cover of flora sampled within KPC Saline Barrens.

DISCUSSION

The overall goal of the research was to collect data for later comparisons, e.g. baseline data. While some data has been collected during earlier studies, these were not in-depth nor in a form serviceable for direct quantitative comparisons. Nonetheless, with the data available [this report and the 2008 study cited above and data from three study sites (see site history above)], it is possible to provide some preliminary assessments. These, however, are not to be considered definitive at this time and very well may be only temporal. This survey found that the number of individuals of *Hymenoxys texana* increased and the number of populations has also increased. The reasons for these increases are not known, but seem to be a result of very favorable climatic conditions during the inventory years and changes in land use. The climate during the past several years was warmer and wetter, the effects of which, while understandable, are not yet understood for *H. texana*. Land use changes included cessation of both planting of row crops and livestock grazing, the major effect being removal of major disturbance.

Another major result of the study is the description of the Houston Saline Prairie Association. *Hymenoxys texana* is limited to two phases of this association. Unfortunately, few high quality sites of Phase 2 are extant. Interestingly, the area also supports 18 plant species that are considered rare or regionally significant (Table 1). Undoubtedly, efforts directed toward the preservation of *H. texana* should benefit these.

Finally, a checklist of the flora of Warren Ranch and Jack Road prairies (Appendix) is completed. Prior to this, only the Katy Prairie proper had a checklist. These accounts are important for documenting later changes in the vegetation composition.

Apparently, *Hymenoxys texana* is sensitive to land use practices, climate (especially rainfall and temperature, during the growing season and possibly at other times), and other factors such as salinity, microclimate, seasonal precipitation variation, etc. The exact nature of the response of the species to these conditions awaits further investigation. Thus, this report serves mainly as an invitation to gather additional data over the next several years. An important facilitation would be to compare populations of the *H. texana* outside of the Houston Coastal Prairies in Trinity County (Poole et al. 2007). This would permit comparisons between the disjunct areas.

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Appendix I. Checklist of the flora of Warren Ranch and Jack Road Prairies

The annotated checklist is divided into pteridophytes, gymnosperms, and flowering plants, which are subdivided into monocots and dicots. Family, genus, and species are arranged alphabetically beneath each major heading. Nomenclature follows Jones et al. (1997), Turner et al. (2003), and United States Department of Agriculture, Natural Resource Conservation Service (2011). Collectors and collection numbers are given as follows: AT = Anita Tiller, JS = Jason Singhurst, KC = Katie Cook, LB = Larry Brown, NS = Nancy Shackelford, and WN = Wesley Neman. An asterisk (*) denotes an introduced species. Vouchers verified at BAYLU and KPCH Herbarium.

PTERIDOPHYTA (FERNS AND FERN ALLIES)

Aspleniaceae

Asplenium platyneuron (L.) B.S.P.

LYGODIACEAE

Lygodium japonicum (Thunb.) Sw., JS, NS, & WN 17336*

OPHIOGLOSSACEAE
Ophioglossum crotalophoroides Walt., JS, NS, & WN 17320

POLYPODIACEAE
Pleopeltis polypodioides (L.) Andrews & Windham

CONIFERS

CUPRESSACEAE
Juniperus virginiana L., KC 154

PINACEAE
Pinus taeda L., JS, NS, WN, & AT 17916

MONOCOTS

AGAVACEAE
Yucca louisianensis Trel., JS, NS, WN, & AT 17926

ALISMATACEAE
Sagittaria lancifolia L., KC 143

AMARYLLIDACEAE
Hypoxis hirsuta (L.) Coville, JS, NS, & WN 17339

ARACEAE
Peltandra virginica (L.) Schott, JS 18360

COMMELINACEAE
Commelina erecta L., KC 22
Tradescantia hirsutiflora Bush, JS, NS, WN, & AT 17942
Tradescantia occidentalis (Britt.) Smyth, KC 48
Tradescantia subacaulis Bush, JS, NS, WN, & AT 17978

CYPERACEAE
Carex festucacea Schkuhr ex Willd., JS, NS, WN, & AT 17954
Carex meadii Dewey, JS, NS, & WN 17354
Carex microdonta Torr. & Hook., JS, NS, WN, & AT 17394
Carex triangularis Boeckeler, JS 18258
Cyperus articulatus L., KC 88
Cyperus entrerianus Boeckl, JS, NS, WN, & AT 17973*
Cyperus iria L., KC 128
Cyperus polystachyos Rottb., KC 92
Cyperus pseudovegetus Steud., JS, NS, WN, & AT 17371, JS & WN 17891
Cyperus squarrosus L., JS, NS, WN, & AT 17855; 17980
Cyperus strigosus L., JS, NS, WN, & AT 17979
Cyperus sp., JS 18361
Eleocharis microcarpa Torr., JS, NS, WN, & AT 17340; JS 18247
Eleocharis montana (Kunth) Roem. & Schult., JS, NS, WN, & AT 17983
Eleocharis obtusa (Willd.) Schult., KC 153, JS, NS, WN, & AT 17370
Eleocharis sp., JS, NS, WN, & AT 17984
Fimbristylis caroliniana (Lam.) Fernald, KC 109
Fimbristylis puberula (Michx.) Vahl, KC 109

Kyllinga odorata Vahl, JS 18378
Isolepis carinata Hook & Arn. ex Torr., JS, NS, WN, & AT 17348
Rhynchospora colorata (L.) H. Pfeiffer, KC 123
Rhynchospora corniculata (Lam.) Gray, KC 169, JS 18365
Rhynchospora glomerata (L.) Vahl, KC 109
Rhynchospora rariflora (Michx.) Ell., JS & WN 17988
Rhynchospora recognita (Gale) Kral, JS & WN 17905
Scleria georgiana Core, JS, NS, WN, & AT 17966
Scleria pauciflora Muhl. ex Willd. var. *pauciflora*, JS, NS, WN, & AT 17937
Scleria triglomerata Michx., JS, NS, WN, & AT 17974

IRIDACEAE
Herbertia lahue (Molina) Goldblatt, LB s.n.
Sisyrinchium angustifolium Mill., KC 39, JS 18251
Sisyrinchium atlanticum Bickn., JS, NS, WN, & AT 17928
Sisyrinchium campestre Bickn., JS, NS, WN, & AT 17351
Sisyrinchium minus Engelm. & Gray, JS, NS, WN, & AT 17350
Sisyrinchium rosulatum Bickn., KC 69, JS, NS, WN, & AT 17380, JS 18492

JUNCACEAE
Juncus brachycarpus Engelm., KC 54
Juncus bufonius L., JS, NS, WN, & AT 17399, JS 18246
Juncus diffusissimus Buckley, KC s.n., JS, NS, WN, & AT 17358
Juncus capitatus Weigel, JS, NS, WN, & AT 17981*
Juncus coriaceus Mack., JS, NS, WN, & AT 17323
Juncus effusus L., JS, NS, WN, & AT 17383; JS 18245
Juncus marginatus Rostk., KC 8, 5, 98
Juncus roemerianus Scheele, JS, NS, WN, & AT 17955
Juncus validus Coville var. validus, KC 99

LEMNACEAE
Lemna minor L.

LILIACEAE
Allium drummondii Regel, LB s.n.
Cooperia drummondii Herbert, KC 107, JS 18399
Cooperia pedunculata Herbert, KC s.n.
Cooperia traubii Hayward, KC 001
Nothoscordum bivalve (L.) Britt., JS, NS, & WN 17319
Schoenolirion wrightii Sherman, LB s.n., JS 18257, JS 18488

MARANTACEAE
Thalia dealbata Fraser ex Roscoe, JS, NS, WN, & AT 17941, JS 18363

ORCHIDACEAE
Spiranthes cernua (L.) Rich., JS & WN
Spiranthes vernalis Engelm. & Gray, KC 10

POACEAE
Agrostis elliottiana Schult., LB s.n.
Agrostis hyemalis (Walt.) B.S.P., JS & NS 17908
Aira elegans Willd. ex Kunth, JS, NS, WN, & AT 17939
Alopecurus carolinianus Walt., KC s.n.& LB, JS 18493
Andropogon glomeratus (Walt.) B.S.P., JS & WN 17890
Andropogon virginicus L. var. *virginicus*, JS & WN 17991
Aristida lanosa Muhl. ex Ell., JS & WN 17860
Aristida oligantha Michx., JS & WN 17869, JS 18373
Aristida purpurascens Poir., JS & WN 17889
Axonopus fissifolius (Raddi) Kuhlm., KC 73, JS & WS 17859
Bothriochloa laguroides (DC.) Herter, KC 44, JS & WN 17861
Bothriochloa longipaniculata (Gould) Allred & Gould, KC 93
Bouteloua curtipendula (Michx.) Torr., WN s.n.
Bouteloua rigidiseta (Steud.) Hitchc., JS & WN 17873
Briza minor L. , JS, NS, & WN 17357*
Bromus catharticus Vahl, JS, NS, WN, & AT 17326 & 17369*
Cenchrus spinifex Cav., KC s.n.
Chasmanthium latifolium (Michx.) Yates, JS & WN 17997
Chloris ×subdolichostachya Müll. Berol. (pro sp.) [*cucullata × verticillata*], KC 64, 135, JS & WN 17878 *
Chloris texensis Nash, JS & WN 17858
Chloris verticillata Nutt., JS & WN 17857
Cynodon dactylon (L.) Pers., KC 116, JS, NS, WN, & AT 17332*
Dichanthelium aciculare (Desv. ex Poir.) Gould & Clark subsp. *aciculare*, JS & WN 17994
Dichanthelium acuminatum (Sw.) Gould & Clark, JS, NS, WN, & AT 17932
Dichanthelium consanguineum (Kunth) Gould & Clark, KC s.n.
Dichanthelium dichotomum (L.) Gould, JS, NS, & WN 17313, JS 18366
Dichanthelium linearifolium (Scribn. ex Nash) Gould, JS, NS, WN, & AT 17927
Dichanthelium oligosanthes (Schult.) Gould subsp. *scribnerianum* (Nash) Freckmann & Lelong, JS, NS, WN, & AT 17938
Dichanthelium scoparium (Lam.) Gould, KC 71
Dichanthelium sphaerocarpon (Ell.) Gould, KC 58, JS 18374
Dichanthelium villosissimum (Nash) Freckmann var. *villosissimum*, KC s.n., JS 18249
Distichlis spicata (L.) Greene, JS & WN 17877
Elymus virginicus L., JS & WN 17999
Eragrostis intermedia Hitchc., KC s.n.
Eragrostis secundiflora Presl subsp. *oxylepis* (Torr.) S.D. Koch., KC 48,87,100,108, JS & WN 17862, JS 18384
Elionurus tripsacoides Humb. & Bonpl. ex Willd., JS & WN 17864
Hordeum pusillum Nutt., WN s.n
Leersia hexandra Sw. KC 114
Leptochloa fusca (L.) Kunth ssp. *fascicularis* (Lam.) N. Snow, KC 134
Limnodea arkansana (Nutt.) L.H. Dewey, JS 18372
Lolium perenne L., JS 18250
Muhlenbergia capillaris (Lam.) Trin., JS, NS, WN, & AT 17397, JS & WN 17898
Panicum hemitomon Schult., KC 142, JS 18385
Panicum virgatum L., KC 138
Parapholis incurva (L.) C.E. Hubbard, WN s.n.
Paspalum floridanum Michx., KC 117,137
Paspalum langei (Fourn.) Nash, KC s.n.

Paspalum monostachyum Vasey, JS & WN 17876
Paspalum notatum Flueggé, KC 18,46 *
Paspalum plicatulum Michx., KC 86, JS & WN 17870
Paspalum pubiflorum Rupr. ex Fourn., KC 146
Paspalum setaceum, KC 15,152
Paspalum urvillei Steud., KC 56*
Paspalum sp., JS 18368
Phalaris caroliniana Walt., LB s.n.; JS 18242
Piptochaetium avenaceum (L.) Parodi, JS & NS 17906
Poa annua L., JS, NS, WN, & AT 17329
Polypogon monspeliensis (L.) Desf., JS & WN 17985*
Schedonnardus paniculatus (Nutt.) Trel., LB s.n., JS & WN 17879, JS & NS 17910
Schizachyrium scoparium (Michx.) Nash, WN s.n., JS & WN 17872
Setaria parviflora (Poir.) Kerguelen, KC 90,139, JS & WN 17866, JS 18371
Setaria pumila (Poir.) Roem. & Schult. ssp. *pumila*, KC s.n.*
Sorghastrum nutans (L.) Nash, WN s.n.
Spartina spartinae (Trin.) Merr. ex Hitchc., KC 131, JS 18386
Sphenopholis intermedia (Rydb.) Rydb., JS, NS, WN, & AT 17378
Sporobolus clandestinus (Biehler) Hitchc., WN s.n.
Sporobolus indicus (L.) R. Br., KC 70, JS & WN 17865
Sporobolus pyramidatus (Lam.) Hitchc., KC 104, JS, NS, & WN 17324
Steinchisma hians (Ell.) Nash, WN s.n., JS & WN 17863, JS 18397
Stenotaphrum secundatum (Walt.) Kuntze, JS, NS, WN, & AT 17918*
Tridens strictus (Nutt.) Nash, JS & WN 17995
Urochloa platyphylla (Munro ex C. Wright) R.D. Webster, KC s.n.
Vulpia octoflora (Walt.) Rydb. var. *octoflora*, JS, NS, WN, & AT 17923; JS 18244
Willkommia texana var. *texana* Hitchc., JS, NS, WN, & AT 17388, JS & WN 17875, JS & NS 17908

SMILACACEAE
Smilax bona-nox L., JS, NS, WN, & AT 17398

TYPHACEAE
Typha domingensis Pers., JS & WN 18001

DICOTS

ACANTHACEAE
Ruellia humilis Nutt., KC 91, JS 18410

AMARANTHACEAE
Gossypianthus lanuginosus (Poir.) Moq. var. *tenuiflorus* (Hook.) Mears ex Henrickson, KC 159, JS 18394

APIACEAE
Ammoselinum butleri (Engelm. ex S. Watson) Coult. & Rose, LB & JS, NS, WN, & AT 17300
Daucus pusillus Michx., LB s.n.
Eryngium hookeri Walp., KC 96
Sanicula canadensis L., JS, NS, WN, & AT 17931
Limnosciadium pinnatum (Engelm. & Gray) Math. & Const., JS, NS, WN, & AT 17959
Limnosciadium pumilum (Engelm. & Gray) Mathias & Constance, JS, NS, WN, & AT 17969
Trepocarpus aethusae Nutt. ex DC., JS, NS, WN, & AT 17977

AQUIFOLIACEAE
Ilex decidua Walt., KC 147,158, JS, NS, & WN 17337
Ilex vomitoria Walt., KC 146

ASCLEPIADACEAE
Asclepias oenotheroides Cham. & Schltdl., KC 130
Asclepias viridis Walt., KC 41 & LB, JS & WN 17907
Matelea cynanchoides (Engelm.) Woodson, LB s.n.

ASTERACEAE
Ambrosia psilostachya DC., WN s.n., JS & WN 17903
Aphanostephus skirrhobasis (DC.) Trel., JS, NS, WN, & AT 17934
Arnoglossum ovatum (Walt.) H. Rob., KC 30
Arnoglossum plantagineum Raf., JS 18382
Baccharis halimifolia L., JS & WN 17990
Bigelowia nuttallii L.C. Anderson, JS & WN 17996
Boltonia diffusa Ell., JS & WN 17882, JS 18414
Calyptocarpus vialis Less., JS, NS, WN, & AT 17366
Chaetopappa asteroides Nutt. ex DC., JS, NS, WN, & AT 17958
Chrysopsis pilosa Nutt., KC 120, JS 18418
Cirsium horridulum Michx., JS, NS, WN, & AT 17375
Conoclinium coelestinum (L.) DC., JS & WN 17887, JS 18403
Conyza bonariensis (L.) Cronq., KC 129, JS & WN 17883
Coreopsis basilis (Dietr.) Blake., KC s.n.
Coreopsis tinctoria Nutt., KC 7, 120
Eclipta prostrata (L.) L., JS 18404
Elephantopus carolinianus Raeusch., JS, NS, WN, & AT 17914
Erigeron tenuis Torr. & Gray, JS, NS, WN, & AT 17956, JS 18489
Eupatorium compositifolium Walt., KC 129, JS & WN 17887
Eupatorium rotundifolium L., JS & WN 18000
Eupatorium serotinum Michx., JS 18415
Euthamia caroliniana (L.) Greene ex Porter & Britt., WN s.n., JS & WN 17900
Euthamia gymnospermoides Greene, WN s.n., JS & WN 17899, JS 18380
Evax candida (Torr. & Gray) A. Gray, JS, NS, WN, & AT 17386
Evax verna Raf., JS, NS, & WN 17322; JS 18248
Facelis retusa (Lam.) Sch. Bip., JS, NS, WN, & AT 17328
Gaillardia pulchella Foug., JS, NS, WN, & AT 17945
Gamochaeta pensylvanica (Willd.) Cabrera, KC 74; JS 18241
Gutierrezia texana (DC.) Torr. & A. Gray, WN s.n.
Gymnostyles anthemifolia Juss., JS, NS, & WN 17340*
Helenium amarum (Raf.) H. Rock, KC 11,76, JS & WN 17885, JS 18407
Helianthus angustifolius L., JS & WN 17884, JS 18416
Heterotheca subaxillaris (Lam.) Britt. & Rusby, JS, NS, & WN 17355, JS & WN 17895
Hymenoxys texana (Coult. & Rose) Cockerell, JS, NS, & WN 17305
Hymenopappus artemisiifolius DC., LB s.n.
Hypochaeris microcephala (Sch. Bip.) Cabrera, JS, NS, WN, & AT 17387, JS 18491*
Iva angustifolia Nutt. ex DC., JS & WN 17904
Krigia dandelion (L.) Nutt., JS, NS, WN, & AT 17331
Krigia occidentalis Nutt., JS, NS, & WN 17304
Liatris acidota Engelm. & Gray, KC 75, JS & WN 17897, JS 18409
Marshallia caespitosa Nutt. ex DC., LB s.n.

Packera glabella (Poir.) C. Jeffrey, JS, NS, WN, & AT 17924
Palafoxia rosea (Bush) Cory, JS & WN 17868, JS 18401
Pyrrhopappus carolinianus (Walt.) DC., KC 13
Rudbeckia hirta L., KC 121, JS & WN 17856, JS 18400
Rudbeckia texana (Perdue) P. Cox & Urbatsch, JS & WN 17998, JS 18405
Senecio ampullaceus Hook., JS, NS, WN, & AT 17930
Soliva sessilis Ruiz & Pav., JS, NS, WN, & AT 17309*
Solidago odora Ait., JS & WN 17989
Solidago sempervirens L., JS & WN 17902
Sonchus asper (L.) Hill, JS 18256
Symphyotrichum ericoides (L.) G.L. Nesom, JS & WN 17881
Symphyotrichum patens (Aiton) G.L. Nesom, JS & WN 17993
Thelesperma flavodiscum (Shinners) B.L. Turner, LB s.n.
Thurovia triflora Rose, KC 8, JS & WN 17880, JS 18392
Vernonia baldwinii Torr., JS 18364
Verbesina virginica L., JS & WN 17986
Xanthium strumarium L., JS & WN 17801

Boraginaceae
Heliotropium curassavicum L., KC 173, JS, NS, WN, & AT 17400, JS 18377
Heliotropium procumbens Mill., KC 172
Myosotis macrosperma Engelm., JS, NS, & WN 17356

Brassicaceae
Cardamine pensylvanica Muhl. ex Willd., JS 18482
Coronopus didymus (L.) Sm., JS 18483*
Lepidium densiflorum Schrad., KC 34, JS, NS, & WN 17316
Lepidium virginicum L., JS, NS, WN, & AT 17347

Cactaceae
Opuntia humifusa (Raf.) Raf., JS, NS, WN, & AT 17971, JS 18379

Callitrichaceae
Callitriche heterophylla Pursh, JS, NS, WN, & AT 17349 & JS, NS, & WN 17341
Callitriche peploides Nutt., JS, NS, WN, & AT 17975

Campanulaceae
Lobelia puberula Michx., JS & WN 17888
Triodanis biflora (Ruiz & Pav.) Greene, WN s.n.
Triodanis perfoliata (L.) Nieuw., LB s.n.

Caprifoliaceae
Lonicera japonica Thunb., KC 42

Capparaceae
Cleomella angustifolia Torr., LB s.n., JS 18383

Caryophyllaceae
Cerastium glomeratum Thuill., JS, NS, WN, & AT 17308
Lepuropetalon spathulatum Ell., JS, NS, & WN 17318
Minuartia drummondii (Shinners) McNeill, JS, NS, WN, & AT 17968; 18260

Sagina decumbens (Ell.) Torr. & A. Gray, JS, NS, WN, & AT 17970, JS 18259
Silene antirrhina L., LB s.n.
Silene gallica L., LB s.n., JS 18263*
Spergularia echinosperma (Celak.) Asch. & Graebn., JS, NS, WN, & AT 17377
Stellaria media (L.) Vill., JS, NS, WN, & AT 17307*

CHENOPODIACEAE
Atriplex cristata Humb. & Bonpl. ex Willd., JS, NS, WN, & AT 17960
Atriplex texana S. Watson, KC 101, JS, NS, WN, & AT 17393, JS 18390

CISTACEAE
Lechea mucronata Raf., JS, NS, WN, & AT 17957
Lechea san-sabeana (Buckley) Hodgdon, JS, NS, WN, & AT 17944

CLUSIACEAE
Hypericum drummondii (Grev. & Hook.) Torr. & Gray, KC 105, JS 18395
Hypericum hypericoides (L.) Crantz, JS, NS, WN, & AT 17951

CONVOLVULACEAE
Dichondra carolinensis Michx., WN s.n.

CONVOLVULACEAE
Evolvulus sericeus Sw., KC 65, JS, NS, & WN 17346
Ipomoea cordatotriloba Dennst., KC s.n., JS & WN 17874

CRASSULACEAE
Crassula aquatica (L.) Schoenl., LB s.n., JS, NS, & WN 17335, JS 18264

DROSERACEAE
Drosera brevifolia Pursh, JS, NS, WN, & AT 17962

EBENACEAE
Diospyros virginiana L., KC 155

EUPHORBIACEAE
Chamaesyce maculata (L.) Small, KC 171
Chamaesyce sp., JS 18408
Cnidoscolus texanus (Müll. Arg.) Small, KC 83
Croton argyranthemus Michx., LB s.n.
Croton capitatus Michx. var. *lindheimeri* (Engelm. & Gray) Müll. Arg., KC 115, JS 18419
Croton glandulosus L., JS 18412
Croton michauxii G.L. Webster, JS & WN 17992
Euphorbia spathulata Lam., JS, NS, & WN 17315 & JS, NS, WN, & AT 17359
Stillingia sylvatica L., JS, NS, WN, & AT 17384
Triadica sebifera (L.) Small, KC 162*

FABACEAE
Baptisia bracteata Muhl. ex Ell. var. *leucophaea* (Nutt.) Kartesz & Gandhi, JS, NS, WN, & AT 17947
Baptisia sphaerocarpa Nutt., JS18484
Chamaecrista fasciculata (Michx.) Greene, KC 29, JS 18396
Desmanthus illinoensis (Michx.) McM. ex Robins. & Fern., KC 94

Galactia sp., JS 18387
Lupinus subcarnosus Hook., JS, NS, WN, & AT 17396
Medicago polymorpha L., JS, NS, WN, & AT 17330*
Mimosa strigillosa Torr. & A. Gray, KC 168, JS 18393
Neptunia lutea (Leavenworth) Benth., JS, NS, WN, & AT 17936
Neptunia pubescens Benth., KC 20
Prosopis glandulosa Torr., JS, NS, WN, & AT 17921
Sesbania drummondii (Rydb.) Cory, JS 18411
Sesbania herbacea (Mill.) McVaugh, JS & WN 17896, JS 18417
Sesbania vesicaria (Jacq.) Elliot , JS 18398
Vicia ludoviciana, JS, NS, WN, & AT 17311

FAGACEAE
Quercus nigra L., JS, NS, WN, & AT 17374
Quercus phellos L., JS, NS, WN, & AT 17950
Quercus margarettae (Ashe) Small, JS, NS, WN, & AT 17948
Quercus stellata Wangenh., JS 18487
Quercus virginiana P. Mill., JS, NS, WN, & AT 17312

GENTIANACEAE
Sabatia campestris Nutt., KC 38, 45, 89, JS, NS, WN, & AT 17382

GERANIACEAE
Geranium caroliniamum L., JS, NS, WN, & AT 17952, JS 18262

HYDROPHYLLACEAE
Hydrolea ovata Choisy., KC 160
Phacelia glabra Nutt., LB s.n., JS, NS, WN, & AT 17362

LAMIACEAE
Hedeoma hispida Pursh, JS, NS, WN, & AT 17379
Mecardonia acuminata (Walt.) Small, JS, NS, WN, & AT 17363, LB s.n.
Monarda punctata L., KC 21
Physostegia pulchella C. L. Lundell, JS, NS, WN, & AT 17952
Salvia lyrata L., JS, NS, WN, & AT 17919
Scutellaria parvula Michx., JS, NS, WN, & AT 17961

LINACEAE
Linum imbricatum (Raf.) Shinners, KC 103, JS, NS, WN, & AT 17331, JS 18485
Linum medium (Planch.) Britt. var. *texanum* (Planch.) Fernald, KC 72
Linum striatum Walt., JS, NS, WN, & AT 17935

LYTHRACEAE
Lythrum alatum Pursh , KC 74, 133, JS 18362

MALVACEAE
Callirhoe involucrata, JS, NS, WN, & AT 17344
Sida ciliaris L., KC 19,119
Sida rhombifolia L., JS & WN 17901
Sida spinosa L., JS 18381

MELASTOMACEAE
Rhexia mariana L., KC 156, JS 18370

MENISPERMACEAE
Cocculus carolinus (L.) DC., JS, NS, WN, & AT 17964

MOLLUGINACEAE
Mollugo verticillata L., WN s.n.

MYRICACEAE
Morella cerifera (L.) Small, JS, NS, & WN 17314, JS & WN 17871

OLEACEAE
Ligustrum sinense Lour., JS, NS, WN, & AT 17943*
Fraxinus pennsylvanica Marsh., JS, NS, WN, & AT 17946; JS 18253, JS 18402

ONAGRACEAE
Gaura lindheimeri Engelm. & A. Gray, KC 47, 123, 124
Gaura longiflora Spach, KC 151 & LB s.n.; JS 18265
Gaura mollis James, JS 18389
Gaura sp., JS 18413
Ludwigia linearis Walter, KC 67
Ludwigia octovalvis (Jacq.) P.H. Raven, KC 140
Ludwigia peploides (Kunth) P.H. Raven, KC 141
Oenothera laciniata Hill, KC 33,66; JS 18261
Oenothera linifolia Nutt., JS, NS, WN, & AT 17976
Oenothera spachiana Torr. & A. Gray, JS & NS 17912
Oenothera speciosa Nutt., KC 36
Oenothera heterophylla Spach, JS, NS, WN, & AT 17972

OXALIDACEAE
Oxalis dillenii Jacq., KC 144, JS 18243
Oxalis violacea L., JS, NS, WN, & AT 17967

PASSIFLORACEAE
Passiflora incarnata L. , JS, NS, WN, & AT 17372

PLANTAGINACEAE
Plantago aristata Michx., KC 3, JS & NS 17911; JS 18252
Plantago elongata Pursh, JS, NS, WN, & AT 17301, JS 18494
Plantago pusilla Nutt., JS, NS, WN, & AT 17925
Plantago rhodosperma Decne., JS, NS, WN, & AT 17963
Plantago virginica L., JS, NS, WN, & AT 17364 & JS, NS, & WN 17334

POLEMONIACEAE
Phlox drummondii Hook., JS, NS, & WN 17317

POLYGONACEAE
Polygonum hydropiperoides Michx., KC 111, JS 18369
Rumex crispus L., JS, NS, WN, & AT 17929*
Rumex hastatulus Baldw., KC 35, 55, JS, NS, & WN 17342, JS 18480

PORTULACACEAE
Phemeranthus parviflorus (Nutt.) Kiger, KC 63
Portulaca pilosa L., JS & WN 17892, JS 18376
Portulaca umbraticola Kunth, JS & WN 17893

PRIMULACEAE
Anagallis arvensis L., JS, NS, WN, & AT 17389*
Anagallis minima (L.) Krause, JS, NS, WN, & AT 17310

RANUNCULACEAE
Clematis crispa L., KC 165, 166
Ranunculus pusillus Poir., JS, NS, WN, & AT 17940
Ranunculus laxicaulis (Torr. & Gray) Darby, KC 32
Ranunculus platensis Spreng., JS 18486

RHAMNACEAE
Berchemia scandens (Hill) K. Koch , JS, NS, WN, & AT 17381

ROSEACEAE
Crataegus crus-gallii L., JS, NS, WN, & AT 17365
Crataegus marshallii Eggl., KC 113, JS, NS, WN, & AT 17345
Rosa bracteata J.C. Wendl., KC 163, JS, NS, WN, & AT 17345, JS & WN 17886
Rubus arguta Link, JS, NS, WN, & AT 17922
Rubus riograndis Bailey, JS, NS, WN, & AT 17326

RUBIACEAE
Diodia teres Walt., KC 80, JS 18406
Diodia virginiana L., KC 84, 97
Galium tinctorium L., JS, NS, WN, & AT 17368
Houstonia micrantha (Shinners) Terrell, JS, NS, WN, & AT 17301
Houstonia rosea (Raf.) Terrell, JS, NS, & WN 17303
Polypremum procumbens L., JS, NS, WN, & AT 17920
Stenaria nigricans (Lam.) Terrell, KC 70

RUTACEAE
Zanthoxylum clava-herculis L., JS, NS, WN, & AT 17373

SALICACEAE
Salix nigra Marsh., JS, NS, WN, & AT 17391

SAPOTACEAE
Sideroxylon lanuginosum Michx., JS, NS, WN, & AT 17949

SCROPHULARIACEAE
Agalinis heterophylla (Nutt.) Small ex Britton, KC 40, JS & WN 17894
Agalinis purpurea (L.) Pennell, JS 18375
Castilleja indivisa Engelm., KC 28
Gratiola flava, JS, NS, & WN 17321 & JS, NS, WN, & AT 17385
Gratiola brevifolia Raf., JS 18367
Gratiola neglecta Torr., JS 18255
Gratiola virginiana L., JS 18254

Lindernia dubia (L.) Pennell, JS, NS, & WN 17353
Nuttallanthus canadensis (L.) Sutton, JS, NS, WN, & AT 17953
Veronica peregrina L., JS, NS, & WN 17343

SOLANACEAE
Capsicum annuum L. var. *glabriusculum* (Dunal) Heiser & Pickersgill, KC 102*

ULMACEAE
Celtis laevigata Willd. JS, NS, WN, & AT 17392

URTICACEAE
Parietaria pensylvanica Muhl. ex Willd., JS, NS, & WN 17306
Urtica chamaedryoides Pursh, JS, NS, WN, & AT 17376

VALERIANACEAE
Valerianella florifera Shinners, JS, NS, WN, & AT 17369
Valerianella radiata (L.) Dufr., JS, NS, WN, & AT 17933, JS 18481

VERBENACEAE
Callicarpa americana L., JS, NS, WN, & AT 17395
Phyla lanceolata (Michx.) Greene, JS, NS, WN, & AT 17965
Phyla nodiflora (L.) Greene, KC 24
Verbena incompta P.W. Michael, KC 118, 125 *
Verbena halei Small, KC 2

VIOLACEAE
Viola affinis Leconte, JS, NS, & WN 17352

VITACEAE
Ampelopsis arborea (L.) Koehne, JS, NS, WN, & AT 17367
Vitis mustangensis Buckl., KC 57, 161